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Is the Weaponization of Space Inevitable?

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IS THE WEAPONIZATION OF SPACE INEVITABLE?

INTRODUCTION

Development of technologies for directed energy and kinetic energy space weapons systems has progressed to the point where the United States (US) could demonstrate concepts within 5-10 years if adequate funding is provided. While Congress debates whether such weapons are needed and should be funded, the Chief of Staff of the Air Force, General Fogleman,[1] and the Commander in Chief of United States Space Command, General Estes,[2] take the position that weapons in space are necessary and inevitable. They view space as the medium where the next step in the natural evolution of military operations will occur.

Operation Desert Storm emphasized the importance of space assets to US military operations, a conclusion as obvious to the rest of the world as to the US. This implies a vulnerability, noted in the recent Army After Next wargame held at the Army War College Jan 27- Feb 6, 1997, which could be exploited by any individual, nation, or state wishing to target the US.[3] We do not know who might be our future adversaries. With the end of the Cold War, relations between countries may be more volatile and more ambivalent, with today's allies possibly tomorrow's adversaries.[4]

This is a concern not only for military operations. Today space assets play a critical role in the everyday life of government, industry, business, and every individual in the US. Their importance to other nations is growing rapidly. Many in the military believe space weapons will be required to protect these vital assets and to ensure US access to space. There is some Congressional support for this view. However, many policymakers and members of Congress

question the need for such systems. They fear these weapons would be destabilizing and would lead to another arms race.

Since the end of World War II and the beginning of the space age the need and the rationale for weapons in space has been discussed and debated, with no consensus. The United States and the Soviet Union, the only space powers in the early years, saw no benefit in initiating an arms race in space because there was no decisive military advantage in orbital weapons over existing strategic weapons. Instead, emphasis was on the use of space for peaceful purposes. There was tacit acceptance of non-lethal military activities in space, such as communications, surveillance, and particularly, reconnaissance.

Two types of systems developed during this period were precursors for future space weapons, intercontinental ballistic missiles (ICBM) and anti-satellite (ASAT) weapons. ICBMs became, and still remain, part of the strategic arsenal of both nations. The development of ASATs was never fully exploited, although both nations continue to pursue relevant systems and technologies.[5,6]

In 1983 President Reagan proposed the Strategic Defense Initiative (SDI) to develop a multi-layer defense against a massive nuclear attack. This system included space weapons and revived the debate on weaponizing space. As the threat diminished with the end of the Cold War, funding for SDI and space weapons was reduced and the debate subsided. Countering weapons of mass destruction, however, remains a national security concern. In the view of some policymakers, the proliferation of weapons of mass destruction and their means of delivery is the greatest single threat to world security.[7] This concern continues to drive a demand for space weaponry.

Although weaponizing space has been a hotly debated topic in the past, particularly during the Reagan Administration, the dramatically changed environment presents a new context in which to address this topic. In the past debate centered on whether or not space weapons would upset the strategic balance between the US and the Soviet Union. Today's debates must address military, political, and economic factors arising from the internationalization and the commercialization of space activities.

The development of space weapons technologies for missile defense and for protecting space assets continues, with new technologies and systems being proposed, as noted in the Air Force's "Global Engagement" strategy.[8] In time systems will be ready for testing, and decisions will be required as to whether or how to proceed. Once the systems exist and are successfully tested, it will be difficult to overcome the momentum for their deployment. Once deployed, it will be difficult to overcome the momentum for their use. If we simply follow this path a decision is made by default, and the weaponization of space becomes inevitable.

The political and economic consequences are of sufficient concern to require a more disciplined approach. It is preferable to identify issues and subject them to open debate before systems are developed and ready to deploy. Issues to consider include whether space weapons are appropriate or if new options offer preferable solutions, and whether military advantages outweigh political and economic liabilities. When these are evaluated in the post Cold War environment, the weaponization of space may be neither necessary nor inevitable.

This paper addresses the need for space weapons and issues and concerns relating to their deployment. It begins with definitions of space weapon and weaponization of space. This is followed by an overview of the evolving global environment, including a summary of space

activities and stakeholders. The advantages and liabilities of space weapons are discussed within the context of national interests, from military, political, and economic perspectives. Alternatives for addressing needs served by space weapons are considered.

WHAT CONSTITUTES WEAPONIZING SPACE?

Definitions.

In order to define what constitutes weaponizing space we must first define what we mean by space weapon and weaponization.

Space Weapon. There is no agreed upon definition for a space weapon, although some have been proposed.[9] Typically it is defined to suit the purposes of the discussion or argument at hand, which is the approach we will take for this paper. We begin with the definition of *weapon* as *an instrument or device of any kind used to injure or kill.*[10] Therefore, a *space weapon* would be *an instrument or device of any kind used to injure or kill in space or from space.* This definition is so broad it would encompass any space asset used in military operations; for example, the Global Positioning System (GPS) would be considered a space weapon.

Weaponization and Militarization of Space. For this discussion we will make a distinction between *militarization* and *weaponization* of space, and will define a *space weapon* as *the specific instrument or device used to injure or kill, i.e., the actual "gun" and/or "bullet," fired into space or from space.* The deployment of such a weapon constitutes *weaponization* of space. Furthermore, *injure or kill* is to imply physical damage or destruction when applied to non-living targets. Use of space or space assets to support military operations and assist in targeting weapons is defined as *militarization* of space.

From early in the space age, the United States and the Soviet Union have used space assets for reconnaissance and intelligence gathering to achieve military objectives and support military operations. During the Cold War reconnaissance activities were accepted as stabilizing.

With each side able to monitor the other's activities and gain some degree of confidence in predicting their behavior, the likelihood of a surprise attack was reduced.[11] Thus the earliest space activities militarized space. Since these systems did not damage or destroy targets and were not considered weapons, space was not weaponized. Both nations pursued concepts and technologies for space weapons throughout the Cold War and continue to do so today. Two functions for space weapons, as antisatellite (ASAT) devices and as anti-ballistic missile (ABM) systems, are at the center of discussion and controversy. However, weapons designed for these purposes often can be used for other purposes as well.

ASAT Systems. The term ASAT denotes any device that can be used to destroy the operational capability of satellites in Earth orbit. These devices can be based on land, at sea, on airplanes, or in space. ASAT systems include (1) the direct ascent launch of a missile carrying either a nuclear or non-nuclear warhead; (2) co-orbital devices with explosive warheads; (3) use of a directed-energy weapon such as a laser; or (4) electronic warfare.[12]

Efforts by the United States and the Soviet Union to develop ASATs have led to some deployments of uncertain success, and to various attempts by the US and the Soviet Union to negotiate bans on the use of these weapons. No agreements were ever reached.[13] There are believed to be no deployed ASATs today, although technology development continues in both the US and Russia.[14]

ABM Systems. Anti-ballistic missile (ABM) systems are designed to counter ballistic missiles in flight. These systems can be strategic or tactical, based on their capability to intercept short range tactical missiles or the long range ICBMs. Strategic ABM systems have been limited

by the 1972 ABM Treaty between the US and the Soviet Union to two sites, one in the Soviet Union protecting Moscow from intercontinental ballistic missiles (ICBM), and one in the US protecting the ICBM site at Grand Forks, ND. Only the Soviet Union has actually deployed an ABM system.

Throughout the Cold war the primary objective in ballistic missile defense was to develop a strategic ABM capability. The use of Scud missiles by Iraq during the Persian Gulf War refocused priorities from strategic to tactical missile defense. Short range tactical ballistic missiles are proliferating in Third World nations, and the US and others are striving to develop tactical ABM systems to defend forces in theater against these missile attacks. Options for these systems include land-, sea-, air-, and space-based interceptors and directed energy weapons such as lasers.

Trajectories of ballistic missiles may cause them to transit space, raising the question of whether they should be considered space weapons. Since they are neither targeting objects in space, nor attacking from space, by our definition they are not space weapons. This capability has existed for decades, e.g., ICBMs, and has not been an issue in the space weapons debate.

Weapons Concepts.

Space weapons can be used to disrupt, degrade, deny, or destroy an adversary's assets in any medium, and include a broad range of systems and concepts. Two recently completed studies directed by the Air Force reveal a range of concepts under consideration as space weapons. The first study, conducted by the Air Force Scientific Advisory Board, "New World Vistas," was commissioned by Air Force Secretary Widnall and Chief of Staff General Fogleman to look at air and space ideas projected into the next 50 years. The second, conducted by the Air University, "Air Force 2025," also was directed by General Fogleman. Its purpose is to look at concepts and

capabilities the US will require to remain the dominant air and space power in the future. Three categories of weapons concepts considered in these studies are relevant to this discussion, space strike weapons, space guided weapons, and information warfare.

Space Strike Weapons are defined as systems of space-based weapons intended to hit targets in space or on earth as well as ground-, air-, and sea-based weapons intended to hit space targets.[15] They fall into two categories: kinetic energy weapons which are projectiles launched from space or into space, and directed energy weapons which include lasers and high power radio frequency (RF) weapons. RF weapons can damage electronics, but are otherwise nonlethal. Lasers can be lethal or nonlethal, depending on the level of power employed. Some examples follow.[16,17]

Kinetic Energy.

Constellations of space-based interceptors to attack ballistic missiles in flight with ability to destroy on impact.

Orbiting rods of depleted uranium with ability to penetrate hundreds of feet into the earth. They are equipped with small boost rockets and GPS guidance electronics, and commanded by ground controllers. These rods can be used against airborne targets.

Directed Energy.

Electromagnetic radiation weapons on spacecraft able to project beams of radio frequency (RF) energy over long distances to either space or ground targets for the purpose of degrading or destroying electronics.

Space-based high energy lasers to destroy a target, or nonlethally to degrade or temporarily disrupt performance.

Ground-based laser systems firing beams from earth onto space targets.

Other concepts.

Rendezvous weapons, e.g., small satellites that close in on enemy space assets and spray paint onto sensors or solar panels or nudge spacecraft out of orbit.

Small, ground-based pulsed lasers to clear low-altitude space debris, and to be used against small satellites.

Space Guided Weapons are concepts which do not project power to or from space, but function with direct input from space assets. Following are several examples.

Synthetic aperture radar images from low earth orbit satellites to guide cruise missiles.[18]

Space based surveillance and tracking sensors to support land- and sea-based ballistic missile interceptors.[19]

Precision targeted munitions using a combination of GPS and hyperspectral sensors.[20]

Information Warfare. Information warfare (IW) includes use of electronic and information tools and techniques, sometimes supported or combined with space assets, for offensive and defensive operations. It is still being defined, but it encompasses at least the seven distinct forms presented below, some old and some new, for the protection, manipulation, degradation, and denial of information.[21]

Command-and-Control Warfare (C2W) includes attacks on systems to cut off the enemy's command structure from its command forces.

Intelligence-Based Warfare (IBW) consists of the design, protection, and denial of systems that seek knowledge to dominate the battlespace.

Electronic Warfare (EW) uses radioelectronic or cryptographic techniques to degrade the transfer of information.

Psychological Warfare (PsyWar) uses information against the human mind and includes: operations against the national will, operations against opposing commanders, operations against troops, and cultural conflict.

Hacker Warfare (HW) refers to attacks on computer networks with effects ranging from total paralysis to intermittent shutdown, and includes theft of information or services, illicit systems' monitoring, and injection of false message traffic.

Economic Information Warfare (EIW) includes blocking or diverting information to pursue economic dominance.

Cyberwarfare (CW) includes information terrorism which exploits systems to attack individuals, semantic attack which causes systems to generate incorrect answers, and simulated conflict using virtual reality.

Any of these techniques may use space assets in their operations. For instance, communications satellites may be used to relay commands or information for operations using any of these forms. Some of these forms have the capacity for extensive disruption and destruction of the function of vital systems without causing direct physical damage. Since these are not guns or bullets, by our definition they are not space weapons. Thus, IW does not weaponize space.

From a different perspective, information is considered the fifth environment in which conflict is waged and military operations are executed. It can be dominated or controlled just as

land, sea, air, and space.[22] IW weapons target an adversary's assets and functions in the information environment. In this scheme, information warfare is either an alternative or a complement to land, sea, air, and/or space warfare. Space assets provide support as needed.

Weapons systems that require guidance or targeting information from space assets are not considered space weapons unless the instrument or device that produces the physical damage or destruction does so in space or from space. By our definition weapons guided by information from space systems are not space weapons. This is controversial, however, with the argument being that the space asset is integral to the function of the weapon system, therefore, it is a space weapon. Such weapons are in a "gray" category, construed as within the bounds of militarization of space, or as space weapons, to suit the position of the contenders. In any case, these systems are not as politically contentious as space strike weapons. Deployment of space strike weapons unequivocally weaponizes space. Therefore, in this paper we will focus on the necessity and inevitability of deploying space strike weapons, using the term *space weapon* for *space strike weapon.*

THE EVOLVING ENVIRONMENT

The strategic environment which frames the context for the space weapons debate has evolved from the latter part of the Cold War. This evolution is reflected in the change in emphasis of our national interests as described in the 1996 National Security Strategy of Engagement and Enlargement. During this period space activities expanded worldwide in a new era of international cooperation. Nations are pooling their resources to fund civilian space programs, and a commercial market is growing with international consortia being the major players. The number of stakeholders is increasing with the level of international cooperation.

Past debates on space weapons occurred in an environment considerably different from the current one. Some previous arguments are still relevant, but new considerations arise from the growth in commercial and international space activities and changes in the strategic environment. If space weapons are to be considered for deployment, the degree to which they enhance national security interests in this environment must be established.

Debates on these weapons began during the Cold War and culminated during the Reagan Administration with the SDI. Our interests during the Cold War centered on containing the spread of Communism, nuclear arms control, and maintaining the balance of power between the North Atlantic Treaty Organization and the Warsaw Pact. Development of ASATs was an ongoing pursuit of both the US and the Soviet Union and the primary concern of Cold War debates on space-based weapons until the advent of SDI.

Recent History.

President Reagan proposed SDI in March 1983 to provide a "system-of-systems" multi-layered defense against a massive nuclear attack. This defense included directed energy and/or kinetic energy space-based weapons that could destroy attacking missiles shortly after launch. It was envisioned that constellations of satellites carrying these weapons would provide the ultimate protection against incoming ballistic missiles and would render nuclear weapons obsolete. The Strategic Defense Initiative Organization (SDIO) was established by President Reagan in 1985 to pursue ballistic missile defense technologies, including those for space weapons, and to develop systems capable of defending against the large numbers of ballistic missiles that constituted an attack under Cold War scenarios. Although significant progress was made in system concept and technology development, no systems were developed.

There was significant opposition to SDI or "Star Wars", as it was popularly known. The controversy centered on costs, technical feasibility, and the concern that rather than render nuclear weapons obsolete, it could accelerate the arms race by driving the Soviet Union to overcome the envisioned defenses.

After the fall of the Berlin Wall in 1989, President Bush initiated discussions with the newly established Commonwealth of Independent States (CIS) to work cooperatively in developing a system for Global Protection Against Limited Strikes (GPALS). This would be a smaller scale version of the system originally envisioned by President Reagan and would provide protection from a limited number of ballistic missiles launched by a rogue nation, or an accidental or unauthorized launch from the Former Soviet Union (FSU). There was tentative agreement with Russia to pursue a cooperative effort, but after the presidential election in 1992, the new Democratic administration decided not to pursue these discussions further.

The new Clinton Administration determined the projected threat did not warrant expenditure on systems for global or national missile defense. The only acknowledged threat was in theater, and for that the Administration would support development of ground-based systems capable of intercepting tactical missiles such as the Scud missiles used by Iraq in the Persian Gulf War. Many space programs were either cut drastically or terminated, and technology programs for space based weapons were to be phased out.

The Persian Gulf War proved space support to be indispensable to US military operations, a conclusion recognized by the international community as well.[23] The difficulties incurred in defending forces from Iraqi Scud missile attacks, and a heightened awareness of the potential threat of ballistic missiles available to Third World and rogue nations, revived support for developing missile defenses and protecting space assets. The new Republican Congress in 1994 reopened the debate on missile defense with strong support for both theater ballistic missile defense (TBMD) and national ballistic missile defense (NBMD). Congress significantly increased funding over the levels recommended in the President's budget and included additional funding for space systems.

While the Clinton Administration supports TBMD and the development of technology for a ground-based NBMD system, it has been adamant in its objection to supporting any efforts that would lead to space weapons. However, Congress continues to provide limited research and development funding for space-based missile defense systems to the Ballistic Missile Defense Organization (BMDO), formerly SDIO, and to the Army for ASAT development.[24]

National Interests.

The 1996 National Security Strategy defines our national interests as follows.[25]

Enhancing our security.

Promoting prosperity at home.

Promoting democracy.

Today the direct threat to our territorial integrity, our Democratic system, and our material welfare has diminished significantly.[26] However, there are emerging threats not specific to the US, but global in nature which are of concern to our security. These include terrorism, crime, drug trafficking, ethnic conflict, rapid population growth, environmental decline, and poverty. These can breed economic stagnation, political instability, and sometimes collapse of state governments. The nearly 100 conflicts since the end of the Cold War have virtually all been intrastate affairs.[27]

Although in principle our national interests have not changed since the Cold War, the emphasis and the objectives associated with these interests evolve to reflect our changing perspective. Security concerns are now secondary to, and often defined by, economic interests.[28] The emphasis is on supporting free trade and democratic institutions to enhance US security and prosperity. Many of the problems we face are international or global and can only be addressed through cooperative efforts with other nations. Economic and security interests are inseparable in many cases, with diplomacy increasing in importance as the role of military force decreases.

Space Activities and Stakeholders.

Although the US has reduced its expenditures on space programs, its investment in space is still more extensive than that of any other nation or international consortium. The total 1997 military and civilian space budget worldwide is approximately $38B, with $27B coming from the US. While military activities are expressly designed to support national security interests, civilian

and commercial activities gain considerable political and diplomatic leverage from cooperative efforts with foreign governments and collaboration with the international scientific community.

Commercial investment is rising rapidly and is expected to overtake government investments worldwide.[29] Both the US and the global economy will reap significant benefits from the success of these ventures. The number of stakeholders in space infrastructure is growing worldwide, and the space environment is becoming a resource as important to the global community as land, sea, and air. Many nations either have their own space assets or have access to assets through cooperative agreements or membership in international consortia.

The following is a summary of domestic and foreign space activities. At issue are the potential benefits and detriments of US deployment of space weapons to national military, political, and economic interests.

Domestic Space Activities

The US is engaged in a broad range of space activities which include a classified government sector, a military sector, a civilian sector dominated by the National Aeronautics and Space Administration (NASA), and an expanding commercial sector. A review of these activities follows.

Classified Government. Both the military and the intelligence community make use of a variety of satellites for photographic, electronic, and ocean reconnaissance; early warning; nuclear explosion detection; communications; navigation; meteorology; and geodesy.[30] They support military operations worldwide, identify potential threats, and monitor arms control and non-proliferation agreements.[31]

Military. Until recently the Department of Defense was the primary user of space assets. There are four space military missions, and these are assigned to the United States Space Command (USSPACECOM). They are as follows, with their associated responsibilities.

Space Forces Support launches and operates the space systems that support the other three mission areas, and includes launch and on-orbit satellite command and control operations provided by the Army, Navy, and Air Force Space Commands. The United States Army Space Command (USARSPACE) operates the Defense Satellite Communications System's payloads, and the Navy Space Command (NAVSPACECOM) controls the Transit Maritime Navigation System and Fleet Satellite (FLTSAT) Communications satellites. Air Force Space Command (AFSPC) launches warning, navigation, weather and communications satellites for all services from Cape Canaveral Air Station (AS)/Kennedy Space Center, FL and Vandenburg Air Force Base (AFB), CA; and controls them from Falcon AFB, CO and Onizuka AS, CA.[32]

Space Force Enhancement obtains information required by the warfighter and provides the capability to receive, process, and transmit this information to wherever it is needed. Support to the warfighter includes providing intelligence, communications, weather, navigation, ballistic missile attack warning, and positioning information. Direct support is provided to land, sea, and air forces using satellites controlled by USSPACECOM, supplemented with commercial communications, weather, and multi-spectral imagery satellites.[33]

Space Control enforces space superiority through protection, negation, and surveillance. To protect satellites from potentially hostile situations or dangerous natural events, warning is provided to space system operators by USSPACECOM's Space Control Center at Cheyenne Mountain Air Station, CO. Other measures to reduce vulnerability and increase survivability include: encrypting satellite telemetry and data streams, spread spectrum frequency hopping, and radiation hardening. To ensure that space operations are conducted without interference from co-orbiting space objects, a worldwide space surveillance network detects, tracks, identifies, and catalogs all space objects. Negation includes disrupting, degrading, denying, or destroying space-based support to hostile military forces, and could be accomplished by using conventional weapons to strike an adversary's space launch or ground relay facility or by using ASATs to destroy an adversary's on-orbit assets.[34]

Space Force Application would apply force from or through space against terrestrial targets. The capability to strike through space is provided today with ground-based ICBMs and will be expanded with ballistic missile defenses. The ICBM force serves as a deterrent against countries that possess, or are in the process of developing, weapons of mass destruction. Ballistic missile defense systems could provide land-, sea-, air-, and space-based forces capable of destroying incoming ballistic missiles in order to protect the United States, forward deployed United States forces, friends, and allies from limited ballistic missile strikes.[35]

Civilian. NASA is the most prominent player in this sector. Its objectives are set by Congress and include: expansion of human knowledge, improvement of space vehicles, development and operation of space transportation systems, long-term studies of space activities for peaceful and scientific purposes, preservation of the US as a leader in space science and technology and their application for peaceful purposes, transfer of information to other agencies, and international cooperation.[36] Activities are divided among the following five mission areas.[37]

Mission to Planet Earth monitors the global environment and develops understanding of the effects of natural and human-induced changes on it, with the goal of long-term environment and climate monitoring and prediction. It includes the use of space and airborne platforms to obtain the necessary data.[38]

Aeronautics develops technologies for a new generation of subsonic aircraft and a global air transportation system. The long term goal is to develop concepts and technologies for aerospace systems that will enable flight into and out of space.[39]

Human Exploration and Development of Space is concerned with learning how to live and work in space utilizing its unique environment and resources. It includes research to study natural phenomena in low gravity environments. Long-term goals are to establish a sustained human presence in space, to conduct manned missions to other planets in the solar system, and to stimulate opportunities for commercial development in space.[40]

Space Science studies the Sun, the solar system, the galaxy, and the universe. Robotic missions will explore the Moon, Mars, and near-Earth asteroids. Networks of small probes and landers will be used to study the solar system. The long-term plan is for robotic exploration of interstellar space, and lunar and deep space observatories to explore the universe.[41]

Space Technology includes partnerships and alliances with industry to develop small, low-cost spacecraft, and to develop technology for reusable launch systems. There are plans for partnerships with the commercial sector to transfer technology, and to adapt commercial technology, to enable US industry to develop new space industries, e.g., manufacturing, tourism, space energy.[42]

Other government agencies with a role in the civilian sector are the following.

The Department of Commerce operates weather satellites and the Landsat remote sensing satellite system through the National Oceanic and Atmospheric Administration. It facilitates commercial space businesses through the Office of Air and Space Commercialization and is involved in space issues associated with trade policy and export of items on the Commerce Control List.

The Department of Energy develops nuclear power sources for satellites.

The Departments of Agriculture and Interior use satellite remote sensing data for crop forecasting and map making.

The Department of State develops international space policy and grants export licenses for items on the Munitions List which includes some types of spacecraft and launch vehicles.

The Office of the US Trade Representative, the Office of Science and Technology Policy, the National Security Council, and other White House offices also are players.[43]

Commercial. This sector has expanded over the last decade as a result of Presidential directives and congressional legislation aimed at encouraging the growth of commercial space businesses in the US. The following summarizes present and planned activities and opportunities for new activities in areas now in the research phase.[44]

Communications was the first successful commercial space activity, assisted through passage of the 1962 Communications Satellite Act. Most commercial communications satellites are in geostationary orbit and provide commercial communications and support to the military sector. This is changing now that the Federal Communications Commission has granted several licenses to operate constellations of satellites in low earth orbit (LEO) for mobile communications services. One of these LEO constellations is Motorola's Iridium system of 66 satellites, which will be owned and operated by an international consortium and is expected to become operational in 1998.[45]

Space Transportation, the marketing of launch services, was facilitated by the Commercial Space Launch Act passed in 1984. The largest market segment is for services to launch satellites into geostationary orbit. Future growth opportunities are in the segment offering launches into LEO, driven by the expansion in the telecommunications industry, and launches into suborbital trajectories used primarily for research.[46]

Remote Imaging is a new activity resulting from Clinton Administration policy issued in March 1994 allowing high resolution land remote sensing data to be sold. Since then, the Department of Commerce has licensed several US companies to develop land remote sensing satellite systems with 1 meter resolution.[47]

Future Activities may evolve from present research and experiments, supported primarily by NASA, using the space shuttle and ultimately, the space station. Opportunities will materialize as technology and market forces reduce launch costs. Potential options include factories in space, microgravity materials processing and manufacturing, space tourism, space facilities for scientific experiments, cargo transport.[48,49]

Foreign Space Activities.

The major players in foreign activities are those with launch capability: Russia and other former Soviet Republics as the Commonwealth of Independent States (CIS), the European Space Agency (ESA), China, Japan, India, and Israel. Many other nations either have their own space programs, or share interests and assets in space. A brief summary follows.

Russia/CIS. The budget for the Russian space program has decreased substantially since the collapse of the Soviet Union. Their satellite launch rate has fallen steadily and many programs have slipped. In 1996 US launch totals, 33, exceeded those of Russia, 23, for the first time.[50] However, Russia still maintains constellations of military satellites for reconnaissance, electronic intelligence, and early warning, and dual-use military and civilian systems for communications, navigation, and weather. Russia continues to support the Mir space station, with other countries

paying to have their own cosmonauts visit and stay aboard for weeks or months to perform research. There are agreements for cooperative efforts with ESA and with the US, which include participation in development of the international space station and agreements to compete in the commercial launch services market. Ukraine also is trying to compete in this market and establish its own independent national space program.[51]

ESA. ESA is comprised of fourteen member European nations, Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and United Kingdom, with Canada as a cooperating state. Each of these nations also has their own national space program. ESA activities are all civilian; its charter precludes conducting military space programs. The Ariane launch vehicle provides ESA the capability to launch satellites and compete in the commercial market. ESA has programs in space science and applications, which include remote sensing satellites, microgravity experiments, development of communications and data relay satellites, and cooperative programs with the United States and Russia.[52]

Japan. Japan is third behind the United States and Russia in space expenditures. Its program includes development of launch vehicles; communications, weather, remote sensing, and scientific satellites; a module for the international space station; and other cooperative efforts with the United States. Future plans include competing for commercial space launches, and a manned presence in space. A 1969 resolution passed by the Japanese Diet prohibits Japan from pursuing space programs for other than peaceful purposes.[53,54]

China. China's space program is focused on operating polar and geostationary meteorological satellites, remote sensing satellites, and geostationary communications satellites. It also includes satellites for scientific experiments and materials processing experiments. China competes for launch services in the international market with its Long March launch vehicles, and has cooperative agreements with Russia to participate in robotic missions to Mars and to put Chinese astronauts into orbit.[55,56]

India. In 1980 India became the seventh nation to achieve orbit capability, but many of its satellites have been launched through cooperative agreements with Russia. Although there are space programs in remote sensing and communications systems, it is not certain whether India has military reconnaissance capability. The programs include cooperative efforts with Russia, the United States, and ESA.[57,58]

Israel. In 1988 Israel became the eighth nation to achieve orbit capability. The national space program includes plans for a geostationary communications satellite system and possibly reconnaissance platforms. There are plans to market the Shavit launch vehicle for commercial launches of small payloads. An agreement with Russia for scientific cooperation was signed in 1993.[59,60]

Other Nations With Space Assets or Access.

There are at least 25 other nations that have space programs, which range from those in Brazil and Australia to develop independent launch capability, to the Republic of Gabon with simply a domestic satellite communications network provided on a turnkey basis by Scientific Atlanta of the United States. Only two of these nations are openly hostile toward the United

States: Iraq, which is believed to be developing launch capability; and Iran, which is funding development of its own domestic satellite communications system. Both of these nations are signatories to the International Maritime Satellite Organization (Inmarsat) and the International Telecommunications Satellite Organisation (Intelsat). Inmarsat is a 79 member cooperative which operates a satellite system providing telephone, telex, data and fax services. Intelsat is a commercial cooperative of 136 member nations or signatories which owns and operates a global system of communications satellites serving the entire world, carrying more than half of all international telephone calls and almost all transoceanic television.[61]

Summary.

The US and the Soviet Union were the only nations with space launch capability until 1965 when France established an independent capability. As of the end of 1995 there were 2,322 payloads in orbit, belonging to 28 nations plus ESA, NATO and Intelsat. Of these, 1,335 belonged to Russia, 680 to the United States, 55 to Japan, and 48 to Intelsat.[62] US, Russia, France, China, Great Britain, Spain, Italy, and Israel use space capability for military purposes.

Although many nations are developing indigenous capability, there is a high level of cooperation to optimize use of limited government resources. NASA and ESA are the major players in non-military efforts, but most civilian activities are now cooperative efforts among nations. The commercial sector, with a growth rate of 20% per year, is supplying much of the growing need for infrastructure. These services are provided mainly through international consortia, which develop new systems and ensure access to international markets for products and services.[63] The growing telecommunications industry, a major portion of this sector, is driving growth and competition in both domestic and foreign launch industries.[64] This competition has

promoted investments in new launch vehicles and in commercial launch facilities. Five new spaceports are under development in the US and at least six more, worldwide. These are expected to accelerate development and transform space into a medium dominated by private industry.

This growth can have negative consequences as demonstrated by the competition for limited GEO slots for communications satellites in Asia. In a recent incident a Hong Kong company launched a satellite into an orbital position claimed by an Indonesian company, prompting the Indonesian company to jam the satellite's signals. The situation is unresolved and the satellite antennas were tilted to another angle to prevent further jamming.[65]

The need to ensure access to space is becoming universal. With more nations seeking space access the potential for conflict increases. There is no global regulatory agency with authority to resolve conflict, leaving resolution to the opposing parties. Space weapons might be considered an option, but preferred solutions to problems such as this would minimize potential for hostilities.

SPACE WEAPONS AND NATIONAL INTERESTS

When we consider the advisability of weaponizing space we must take into account national space policy and national interest objectives, as well as international treaties and agreements. The 1996 National Space Policy and the national interest objectives identified in the 1996 National Security Strategy, provide a framework for examining military, political and economic advantages and issues associated with deploying space weapons.

1996 National Space Policy.

The Clinton Administration released its National Space Policy (NSP) on September 19, 1996. The policy states,

"the United States is committed to the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all humanity."

It rejects any claims to sovereignty by any nation over outer space or celestial bodies and rejects any limitations on the right of sovereign nations to acquire data from space. It considers space systems to be national property with rights to pass through, and operation in, space without interference. Interference would be viewed as infringement on sovereign rights.

The NSP, in its Defense Sector Guidelines, identifies four United States Space Command (USSPACECOM) space mission areas: *Space support, Force enhancement, Space control, Force application.* These were discussed more fully in the previous section. It states that space control must provide capabilities to ensure freedom of action in space and denial to adversaries, if necessary, consistent with treaty obligations. The NSP further states the United States will

pursue a ballistic missile defense program to include a theater ballistic missile defense (TBMD) capability, a hedge program for a national ballistic missile defense (NBMD), and an advanced technology program.

The policy does not specifically advocate or oppose the development and use of space weapons. These policy statements are potentially contradictory, since the space control and force application missions may not be consistent with the use of space only for peaceful purposes or with the sovereignty of a nation's space assets, even though the US has defined "peaceful purposes" as the non-aggressive use of space.[66]

This inconsistency may be resolved by an Air Force Space Command strategy and policy analyst's proposal to develop space superiority campaigns with alternatives to spacecraft destruction to achieve the degree of control needed to ensure successful military operations.[67] This approach is driven by the recognition that space is an international medium affected more by commercial interests than civil and military, and that there is an interdependence between these sectors. The recommendation is to develop a range of options, not just spacecraft destruction, to ensure access to space and effective use of space assets during military operations, and to satisfy requirements for USSPACECOM's space control mission.[68]

National Interests and Objectives

The 1996 National Security Strategy of Engagement and Enlargement associates the following objectives with our national interests.[69]

Enhancing our Security.

Deterring and defeating aggression in major regional conflicts.

Providing a credible overseas presence.

Countering weapons of mass destruction.

Contributing to multilateral peace operations.

Supporting counterterrorism efforts.

Fighting drug trafficking and international crime.

Noncombat evacuation, humanitarian and disaster relief operations.

Promoting Prosperity at Home.

Enhancing competitiveness.

Strengthening macroeconomic cooperation.

Enhancing access to foreign markets.

Providing for energy security.

Promoting sustained development abroad.

Promoting Democracy.

Enlarging the community of democratic and free market nations.

Helping preserve new democracies.

Respecting human rights.

Enhancing our Security. Space weapons can support some of the objectives listed under "enhancing our security," as indicated below. From a military perspective they offer many advantages. But political and economic considerations also are important, and from these perspectives they are less attractive.

Major Regional Conflicts. Orbiting space weapons offer protection in regional crises while forces are being mobilized. Their coverage during buildup in theater can reduce risk and buy time. This reduces stress on logistics and can deter opposition to force buildup. The likelihood of the US or its allies being held hostage by missile threats during a crisis would be less. Deployment of these weapons can reduce the number of forces required and can provide backup support in the event hostilities erupt in multiple regions simultaneously. Their constant presence, i.e., "guns always aimed and ready to fire," allows greater freedom of action to pursue political and diplomatic solutions to a regional crisis or conflict.[70]

Overseas Presence. The continuous presence of orbiting space weapons could serve as a deterrent to potential aggressors and assist in maintaining regional stability while protecting US strategic interests and commitments to friends and allies. An overseas presence would exist without extensive use of forward deployed forces. The level of support and protection would increase while allowing reductions in manpower and other assets. Diplomatic tension often associated with overseas basing would be diffused, and allies would enjoy reductions in their defense costs by having space weapons support.

Missile Defense. Weapons of mass destruction (WMD) are proliferating among Third World and rogue nations, as are the missiles capable of delivering these weapons and conventional explosives over increasingly long ranges. This generates a need to deter and defend against possible attacks. Missile defense systems are being developed by the BMDO to provide limited ground-based point and area terminal defense to protect

military forces in theater. The Air Force is developing an Airborne Laser weapon system capable of destroying missiles shortly after launch, in boost or post-boost phase.

The optimum defense against ballistic missiles is considered by advocates of ballistic missile defense to be a multi-layered system-of-systems capable of attacking missiles in any stage of flight, preferably in their boost and post-boost phases. This is when they are most vulnerable, still far from their intended targets, and often, still over the launcher's territory. Space-based kinetic and directed energy weapons are considered one of the more effective options for destroying the longer range missiles early in flight.[71] These systems also have the potential to support other missions, such as air combat, and to supplement air forces in maintaining air superiority.

Military Perspective.

Space weaponization advocates agree with the military view that space is simply another medium for military operations. General Estes, the current CINCSPACE, articulates this position. He believes military operations using spacecraft will evolve in a manner analogous to military operations using aircraft. Estes sees space control and force application as critical to "enhancing our security" because the US is a space-dependent nation, and therefore, vulnerable to hostile groups or powers seeking to disrupt our use of space.[72] The commercialization of the space industry is increasing accessibility to space, leading to greater use and greater opportunity for hostilities. The space control and space force application missions of USSPACECOM imply the need for a space force structure that includes ASATs and defensive and offensive space weapons.[73] The Joint Requirements Oversight Committee (JROC) is considering a proposal to

designate space as an area of responsibility (AOR) or operational combat theater, with CINCSPACE being given a warfighting role in addition to its present supporting role.[74,75]

Affects of Space Weapons on Force Structure. The combined impact of space weapons and increasing use of space systems in military operations could radically change military force structure. Space, or space guided, weapons would be able to strike anywhere, anytime, with great precision. We can envision a world of precision-guided munitions in which the need for tanks and aircraft carriers is questionable.[76] Massed infantry armies are expected to become obsolete because there will no longer be a need to fire large quantities of ammunition to hit a single target. Instead small numbers of highly trained and skilled soldiers with tremendous firepower, modeled after Special Operations forces, would support land operations, reducing the size of land forces without decreasing military power. The structure of the Navy also could change dramatically. Space surveillance coupled with precision-guided missiles and space-based directed or kinetic energy weapons could take over the bombardment role of carrier-based aircraft. Sea-lanes could be controlled more effectively using long-range projectiles targeted from space. Carrier battle groups would no longer be needed. Manpower and logistics requirements and the need for conventional equipment such as tanks and carriers would be drastically reduced.

Increased Cost Effectiveness. Space weapons are versatile systems which allow for more cost effective military operations. Orbiting systems can respond anywhere, anytime; can be used offensively and defensively, as required; and are effective against targets in any medium, land, sea, air, and space. Air-, sea- and land-based systems provide only limited area coverage to protect specific assets. The number of systems required is based on the area to be defended, or

conversely, the area defended is limited by the number of systems available. Constellations of space weapons would be available in any area at all times. They are a force multiplier, supporting multiple missions and/or theaters, simultaneously.

Space weapons cut defense costs by reducing manpower and logistics costs associated with forward-based and prepositioned forces, and overseas basing.[77] They would not eliminate this need. In situations where visibility, or show of force, is key, land, sea, and/or air forces would still be required. Further reductions in manpower and logistics costs are possible because fewer surface-based interceptors would be needed in a theater of operations. With a layered defense and a capability to intercept missiles early in flight, land-, sea-, and air-based systems in any theater, including the US, would be less stressed.

Space Warfare Policy and Doctrine. Before these systems are deployed, a concerted effort is needed to revise military doctrine and tactics, and military force structure, accordingly. Efforts are underway at USSPACECOM to develop a Space Warfare Policy, a Space Power Theory, and Space Doctrine to support the Space Control and Space Force Applications missions. These efforts are driven by three beliefs: the idea of space weapons is gaining acceptance, space assets are the US "center of gravity," and the premise "where commerce goes the military follow." In preparing for the advent of space weapons, USSPACECOM has identified several concerns.[78]

There is no National Security Council policy on how to respond to hostile acts in space, i.e., attacks on US and non-US systems, and specific attacks on DoD systems. Some of the questions to be answered are: Under what conditions would an attack be considered an act of war? How would the US respond? Would the US respond in kind?

There should be a deterrent value to the policy, e.g., the anticipated response should be known to prospective adversaries, and the consequences should be sufficient to deter an attack. A policy decision is needed in time to develop doctrine, strategy, tactics, and conduct training. We cannot afford to wait until an attack occurs. We must know the rules of engagement and be prepared with an appropriate response.

The US should not rely on treaties and international agreements to prevent weapons in space. They are not enforceable. Others could develop and deploy weapons in space without our knowledge.

Space systems need the capability to detect and warn of attack -"if you can't see, you can't respond." Space systems should be provided with sensors to distinguish between a deliberate attack, a natural phenomenon inducing failure, or a normal system failure. Having the capability to warn of attack also is considered a necessity.

A national missile defense is needed as a deterrent to the use of nuclear weapons. There is a concern that a revitalized Russia or China, or a rogue state able to procure long range missiles, would be inclined to launch nuclear missiles at the US if there is no credible defense in place.

It is time to develop and deploy a space counterweapon, we need the ability to "respond in kind" and not be forced into an asymmetrical response if space assets are attacked. The concern is we might be forced into a nuclear response if we do not have the ability to "respond in kind," e.g., with ASATs.

Other Concerns. The results of the Army After Next wargame reinforced a need for space control or space superiority during military operations. Military reliance on space assets

was shown to be a significant liability if an adversary succeeded in neutralizing or destroying US satellites. However, the wargame also identified Unmanned Aerial Vehicles (UAV) as able to compensate for lost space assets.[79]

With the continuing drawdown in forces and the reduced defense budget, the military could be significantly challenged in supporting simultaneously, the various objectives for enhancing our security. Space-based weapons could facilitate that support, particularly in those instances when presence is a concern and when rapid response is required. From a military perspective there is no reason why space should not be weaponized if it is technically feasible, affordable, and if political and legal issues can be resolved. The benefits to national security and to maintaining a military edge in space are believed to offset any negative military effects from other nations attempting to achieve parity.

Political Perspective.

There are a number of treaties and agreements relating to military activities in outer space. Although none expressly forbid the deployment of space weapons, there are constraints which could create an adverse political environment if space weapons are deployed.

International Treaties. The only legal restrictions to placing weapons in space are those identified in the Partial Test Ban treaty, the Outer Space Treaty, the Anti-Ballistic Missile (ABM) Treaty, and the Moon Treaty. [80]

The 1963 Partial Test Ban Treaty, signed by the United States (US), the United Kingdom (UK), and the Union of Soviet Socialist Republics (USSR), bans nuclear weapons tests in the atmosphere, in outer space, and underwater.

The 1967 Outer Space Treaty, signed by the US, the UK, and the USSR, prohibits placing nuclear weapons, or any other weapons of mass destruction, in orbit, or installing them on any celestial bodies.

The 1972 ABM Treaty, signed by the US and the USSR, prohibits ABM systems or components which are sea-, air-, space-, or mobile land-based. It also restricts the location and numbers of ground-based defenses.

The 1984 Moon Treaty prohibits any objects carrying nuclear weapons or weapons of mass destruction from being placed in orbit around the moon, and being placed or used on or in the moon.

Prior to, and during, the SDI era the USSR brought several proposals to the United Nations (UN) to prohibit weapons in space. Their 1981 draft treaty would have prohibited the stationing of weapons of any kind in outer space. In 1983 they drafted a treaty to prohibit the use of force in outer space and from space against earth. In 1985 the USSR proposed the UN General Assembly include an agenda item on "International cooperation in the peaceful exploitation of outer space under conditions of its non-militarization."[81] No action was taken on any of these proposals.

Existing Law. The existing body of law concerning a decision to weaponize space pertains to: sovereignty, peaceful use, international law, and missile defense.

Sovereignty in space is covered by these general principles stated in the Outer Space Treaty.

Article I states that outer space, including the moon and other celestial bodies, are free for exploration and use by all states without discrimination.

Article II states that outer space and celestial bodies are not subject to national appropriation by claim of sovereignty, use or occupation, or other means.

Article IX states that activities in outer space shall be conducted with due regard to the corresponding interests of other states. It also requires international consultations before proceeding with activities which would cause potentially harmful interference with space activities of other parties.

The Outer Space Treaty precludes any claims of sovereignty in space. In addition, since the laws of physics do not allow orbiting space assets to be precluded from overflying another nation's territorial boundaries, sovereignty cannot apply to the medium, only to a nation's assets in space.

Peaceful Use of space is covered in the preamble to the Outer Space Treaty which refers to

"the common interest of all mankind in the progress of the exploration of outer space for peaceful purposes."

Many countries maintain that "peaceful purposes" precludes any military activity in space. The 1958 National Aeronautics and Space Act states,

"It is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

The position of the United States is that "peaceful purposes" means "nonaggressive," and therefore all nonagressive military activities in space are permitted other than those specifically

prohibited.[82] The term "nonaggressive" has not been defined and is interpreted by some proponents of space weapons to allow the use of defensive, as opposed to offensive, weapons.

International Law, as it applies to space, is covered in Article III of the Outer Space Treaty which states,

> "international law, including the Charter of the United Nations (UN)," applies to the use of outer space.

Outer space is analogous in many respects to the high seas and international airspace, which have always been considered available under international law for nonaggressive military uses, such as surveillance, patrolling, and exercises.

> Customary international law permits the use of armed force, to the extent necessary and proportional, to defend a State that is under actual attack or is threatened with imminent armed attack.

The UN Charter prohibits the threat or use of force, but not all military activities, and particularly not self-defensive military action.

> Article 51 of the UN Charter recognizes self-defense as an inherent right under international law which is not impaired by the Charter.[83]

Thus international law would permit the use of defensive space weapons. Proponents of space weapons for purely defensive purposes, propose that a distinction be made to allow for deployment of defensive systems. However, there is no credible method for differentiating between offensive and defensive weapons. This concern is important when considering space systems for ballistic missile defense because such systems can support a broader range of military operations.

Missile Defense has constraints imposed by the ABM Treaty.

Article II defines an ABM system as a system to counter strategic ballistic missiles in flight trajectory.

Article III limits each party to one ABM deployment area having a radius of 150 kilometers and either centered on the national capital or containing ICBM silo launchers. No more than 100 launchers and 100 interceptors are permitted at each site.

Article IV states limitations do not apply to ABM systems or their components used for development or testing.

Article V prohibits developing, testing, or deploying sea-based, air-based, space-based, or mobile land-based ABM systems or components.

In an agreed statement ABM systems based on other physical principles would be subject to discussion and agreement in accordance with Articles XIII and XIV of the Treaty.

The ABM Treaty places serious constraints on NBMD systems, but it is not intended to affect TBMD systems. However, it is becoming increasingly difficult to distinguish between systems with capability to defend against tactical or strategic systems. This has been a topic of negotiation between Russia and the US through the Standing Consultative Commission for the ABM Treaty.[84] More recently Belarus, Kazakhstan, and Ukraine have been included in discussions of this demarcation issue. A tentative agreement was reached in the recent Helsinki talks between President Clinton and President Yeltsin. It was agreed that a theater system would be exempt from ABM Treaty coverage if it were not tested against a missile with a range greater than 3500 kilometers or a velocity greater than 5 kilometers per second. This accord also would prohibit development, testing, or deployment of space-based theater antimissile interceptors.[85]

If this agreement prevails, space weapons for either TBMD or NBMD clearly are precluded. Any future Administration wishing to deploy space weapons for missile defense will have to renegotiate with Russia or abrogate the treaty. Many experts believe effective ballistic missile defenses could aid in preserving peace in the post-Cold War era. Some would prefer that negotiations pursue cooperative efforts for developing and deploying defenses, believing this would counter missile proliferation and serve as a deterrent.[86]

Nuclear Weapons Linkage. Until recently, there were only three nuclear powers other than the US and the Soviet Union: China, France, and Great Britain. Today there are others, such as North Korea and Iraq, believed to be developing nuclear weapons. With the availability of technology and know-how there is fear these numbers will increase and controls will become more difficult. This fear of nuclear proliferation, coupled with the concern for proliferation of WMD, in general, is driving the demand by some Congressional leaders for ballistic missile defenses. Systems capable of defending against tactical ballistic missiles are not an issue. The purpose of the recent Clinton-Yeltsin accord on demarcation between theater and strategic missile defense systems is to ensure that deployment of these systems will not jeopardize the ABM Treaty.

NBMD is a different issue. The ABM Treaty allows for limited defenses of the nation's capital or of an ICBM site. Russia selected to protect Moscow and has a deployed ABM system. The US elected to protect the Grand Forks, ND ICBM site, but has no deployed system. The intent of the treaty is to ensure the deployed system could not provide protection to the entire nation, and is based on the doctrine of Mutual Assured Destruction (MAD). The US and the Soviet Union were each assured if one attacked first with nuclear weapons, the other would have

sufficient remaining nuclear capability to destroy the aggressor. This deterrence strategy has been successful to date.

Space-based systems are specifically banned by the treaty, and this is a source of contention within Congress and between Congress and the Administration. There are those who believe any NBMD system should be designed to be treaty compliant, thus ruling out space-based components, and those who believe the ABM Treaty is no longer viable because of the dramatically changed environment, and that providing for the defense of the nation against a growing missile threat is paramount. They are willing to abrogate the ABM Treaty, if necessary, to provide what they believe to be the appropriate defenses for the nation.

Abrogation of the treaty could have consequences which negate benefits of missile defenses. It could jeopardize nuclear arms control since Russia has linked approval of the START II Treaty and future arms control negotiations to the sanctity of the ABM Treaty. START II would reduce the nuclear arsenals of the US and the Soviet Union, and there are plans to begin START III negotiations once START II is approved. There is concern that if START II is not approved, expansion of nuclear arms will occur as Russia strives to maintain or upgrade nuclear weapons to guarantee a capability to overcome US defenses.

Space weapons can compound nuclear arms control issues. They also raise issues similar to those associated with nuclear weapons, such as: deterrence, counterproliferation, arms control, and strategic stability. During the Cold War the US and the Soviet Union negotiated a number of treaties to address these concerns with respect to nuclear weapons.

The ABM Treaty to deter the use of nuclear weapons.

The Nuclear Nonproliferation Treaty (NPT) and Limited Test Ban Treaty to prevent the spread of nuclear weapons.

The Strategic Arms Limitation Talks (SALT) and the Strategic Arms Reduction Talks (START) to end the arms race and reduce the stockpile of nuclear weapons.

All of these treaties have the goal of ensuring strategic stability.

Deterrence. The ABM Treaty was based on the premise embodied in the MAD doctrine, that deterrence required each side to be incapable of defending against, but having the capability of completely destroying the other. President Reagan proposed the SDI on the premise that a system capable of defending against a massive nuclear attack would make nuclear weapons obsolete, thus, becoming the ultimate deterrent. This premise has never been tested. Many experts believe it is technically unachievable because it is easier to build increasing numbers of weapons than to build impenetrable defenses. Therefore, any defense could be overcome by a sufficiently massive attack.

Although the Soviet Union has been dismantled, its nuclear arsenals still remain. Through START the US and Russia are reducing their nuclear arsenals, but nuclear weapons are not likely to become obsolete in the foreseeable future. WMD are available to terrorists and rogue states. In this environment neither the MAD doctrine nor the SDI premise is applicable. Total annihilation is not an acceptable response to a terrorist or rogue nation attack because devastation would not be limited to the aggressor. A terrorist or rogue nation is not concerned with strategic stability, but rather in promoting instability and gaining power and influence through coercion. Space weapons would serve as a deterrent only if there is proven capability to destroy missiles over the aggressor's territory and if the aggressor lacked sufficient numbers of weapons to

overpower the defenses. This might deter Third World or rogue nations from using ballistic missiles, but it could drive them toward other undesirable alternatives such as cruise missiles. The more powerful nations, e.g., Russia and China, could view space weapons as a threat and their deployment as an invitation to commence with arms races in both space and nuclear weapons.

The use of space weapons by others could not be deterred readily. Attacks could be launched on space assets from the ground or in space, and it might not be possible to determine whether or not is an actual attack. If it were an attack, it could be difficult to identify and/or detect the source. Such attacks could occur whether or not the US chooses to deploy space weapons, and these weapons would be of no value in such an occurrence. World opinion may be the greater deterrent in today's environment and that of the future. However, if the US sets a precedent for using space weapons it will be far more difficult to prevent their use by others, including potential adversaries.

Counterproliferation. The NPT and the Missile Technology Control Regime (MTCR), an agreement which forbids the sale of ground-to-ground missile technology, have been moderately successful in reducing proliferation of nuclear weapons and their delivery systems. However, if there is a break down in arms control negotiations and arms reduction talks as a result of the deployment of space-based weapons, it is conceivable that the NPT and the MTCR could breakdown as well. Other parties could use sales in these areas to obtain financial resources to pursue their own space weapons development.

Although some space weapons are based on sophisticated technologies, others are not. Some, such as ground-based lasers and RF systems, do not require launch capability. It would not be difficult for other nations to develop and use space weapons. These could be

unsophisticated space or ground systems capable of damaging or destroying space assets including weapons systems, e.g., jammers or projectiles. The US has the resources and the technology to be the first to deploy weapons in space, with little or no competition in the immediate future. However, this will encourage others to develop comparable systems and/or to develop the capability to counter these weapons.

Arms Control. Abrogation of the ABM Treaty to deploy space weapons not only would threaten nuclear arms control agreements and risk a new nuclear arms race, it would also set the stage for a competition in space weapons. It can be argued that the Russian economy could not sustain another arms race, but there is no guarantee that Russia would have to go it alone, or that other nations, such as China, or even some of our allies, would not pursue a buildup of space weapons. Even today there is a growing rift between the US and Europe on arms sales on world markets, and a concern that advances in US military technology are not being shared with the Europeans. This is causing Europe to pursue a consolidation of the European defense market and a European Union effort to create a common foreign and security policy. This is expected to occur in the next 5-7 years.[87] It is conceivable that if the US deploys space weapons, Europe will follow and will consider selling these systems on the world market to finance military technology.

Strategic Stability. During the Cold War strategic stability was defined in terms of weapons parity between the US and the Soviet Union. That parity still exists, and although there is less regional stability today, there is less anarchy than there might be if this parity is disrupted by a US shift to space weaponry.

There is tentative cooperation between Russia and the US today, which reduces tension globally and can control rivalry among lesser powers because these great powers are not likely to be drawn in on opposing sides. Deploying space weapons could sacrifice this opportunity to cooperatively maintain cohesion and stability. Russia has been consistent in its opposition to space weapons, and has succeeded in gaining concession from the Clinton Administration to ban space-based weapons for TBMD in the recent Helsinki agreement. US persistence in weaponizing space would negate this agreement and reestablish a contentious relationship with Russia, opening a whole new arena of weapons development to siphon resources from peace-promoting civilian and commercial space projects.

Many objectives supporting our national interests require international cooperation which, in turn, requires effective diplomacy. US diplomatic effectiveness in the international arena is more than a function of power, it also requires integrity and credibility. While deploying space weapons would enhance military power, doing so would violate international treaties and agreements, diminishing both US integrity and credibility. With the US as the sole superpower, and no existing comparable military power, it would be difficult to justify that action within the international community. The US would suffer from reduced credibility in efforts to negotiate cooperative economic agreements or to promote democracy and free markets. In addition it gives license to others to ignore international agreements, setting the stage for anarchy. From a political perspective weaponizing space would be a liability.

Economic Perspective.

Economic aspects to consider in deploying space weapons include their costs relative to other systems and their impact on the defense and national budgets. It also is useful to contrast

the affect of military versus commercial development of space. Space weapons can reduce defense costs, and the savings can be applied to other national needs, but their affect on the national and global economy could result in losses that would more than offset these savings.

Relative Costs of Space Defenses. Missile defense is one example of a missions that can be performed from space or earth, therefore, we can use this to compare relative costs. The capability is not necessarily identical for space-based and earth-based systems. Space systems, because they are orbiting constellations, can provide continuous coverage throughout the globe. Earth-based missile defense is a combination of NBMD and TBMD which we will compare with space-based systems to provide global coverage. These systems and their associated costs are listed in the following tables.

Space System Costs

SYSTEM	COST ($B)	QUANTITY	O&S ($M/yr)
SBI	14	500 Interceptors	150-250
SBL	25	20 Spacecraft	100-500

NBMD System Costs

SYSTEM	COST ($B)	QUANTITY	O&S ($M/yr)
Land*	4-9	100 Interceptors	150
Sea*	3+	22 Cruisers/650 Int	TBD
***SBS**	5	24 Satellites	150

* Sea- and land-based systems require SBS for maximum performance

TBMD System Costs

SYSTEM	COST ($B)	QUANTITY	O&S ($M/yr)
ABL	6	7 Aircraft	500
THAAD*	13	1200 Interceptors	TBD
NTW*	3+	TBD	TBD
***SBS**	5	24 Satellites	150

* Sea- and land-based systems require SBS for maximum performance

One of the economic concerns with space systems is their cost effectiveness. A comparison of missile defense systems indicates development and deployment costs for space-based missile defense systems compare favorably with those for air-, sea- and land-based missile defense systems.[88] For NBMD a single site land-based system of 100 interceptors with a space-based sensor (SBS) would cost $9-14B; each additional site would cost $2-3B, with 5-6 sites needed for complete coverage of the US, adding another $10-18B for NBMD alone.[89]

For TBMD a combination of land (Theater High Altitude Air Defense (THAAD)), sea (Navy Theater Wide (NTW)), and air (Airborne laser (ABL)) systems would cost in excess of $22B, assuming SBS is provided for NBMD.[90] All of these systems are presently funded and should be fielded within the next decade. The costs are consistent with the capability to support two major regional conflicts. If SBS is not provided for NBMD, another $5B must be added. These systems provide limited area coverage, but they cannot provide global coverage without space-based weapons.

A combined air, sea, and land TBMD and NBMD defense would cost a minimum of $31-36B for a capability including one NBMD site with 100 interceptors, and area defense for two theaters. Space weapons could provide global coverage at a cost of no more than $39B if both the space-based interceptor (SBI) and the space-based laser (SBL) are deployed.[91] Thus, space weapons could provide greater capability at a comparable cost.

With the information available it is not possible to directly compare operations and support (O&S) costs for space-based versus terrestrial-based missile defenses. However, we can make an estimate based upon the knowledge that O&S costs for land and sea forces over a 35-year period were 2-3 times greater than those for air forces.[92] Assuming the same ratio applies to

the systems in question here, and given that O&S costs for SBL are equivalent to those for ABL, we conclude that O&S costs for land and sea-based systems are 2-3 times those for SBL.

Space weapons could provide global coverage at a cost equivalent to the combined costs of the NBMD and TBMD systems now being funded. As part of a multi-layered missile defense system they would be a force multiplier. They would not replace all land-, sea-, and air-based weapons systems, but would reduce the number of systems needed, the manpower required to support them, and add capability not even possible with other systems.

Deployment of space weapons could drive a major restructuring of air, land, and sea forces. Capabilities of space assets rather than traditional force structure would determine how missions are planned and executed.[93] With fewer forces O&S costs would decrease military wide. The savings realized could not only compensate for the cost of space systems, but could be used to address budget shortfalls in other areas.

Risks. Basing systems in space is still a risky business. Systems must be robust and designed with considerable redundancy, since once launched, they cannot be returned or readily accessed for repair or maintenance. Launches are fraught with risk and if a launch fails both the satellite and launch vehicle must be replaced.

There are potential methods for reducing the risk of basing systems in space. For instance, NASA's recent successes in repairing and replacing components on the Hubble space telescope establishes a precedent for repair and maintenance of satellites and payloads in LEO. Furthermore, Russia has demonstrated repeatedly in its space station program the ability to transport crews and supplies to the space station and perform repairs and modifications as

needed.[94] The increasing number of satellites in LEO may create a market and a new industry for the repair and maintenance of satellites.

Furthermore, the development of the Air Force's Evolved Expendable Launch Vehicle (EELV) and NASA's Reusable Launch Vehicle (RLV) are intended to make space access routine, and thereby reducing the risk of repeated one-of-a-kind developments. The EELV is expected to provide a 20-50% reduction in launch costs; the RLV is expected to reduce costs by 50% initially, with a long term goal of reducing costs by factors of 10-100.[95] Also, there is renewed interest in developing a space plane which could be used for satellite launch and for cargo and passenger transport, with the commercial sector now seeking investors.[96] Once space access becomes routine, economies of scale in space and space launch systems may be realized, reducing costs and risks for space weapons.

Commercial Considerations. The space business is booming, with commercial space revenues surpassing the value of traditional government activities. The market is growing at a rate of 20% a year while government spending in civil and military space declines. The worldwide market is expected to reach hundreds of billions of dollars.[97] Hot areas today are mobile telecommunications, remote sensing, and direct-to-home television satellites. Industry leaders believe market demand and technological advances will continue to drive down prices and open up new applications for satellites. With completion of the International Space Station the opening of factories in space will approach reality.[98] A recent NASA study indicates if the cost of access to space can be reduced by a factor of 10 from the present cost of approximately $5,000-$10,000 per payload pound, a market will exist for numerous space activities, including space tourism,

space power, and space business parks.[99] The service-based US economy would be a major beneficiary.

Increased activity and access creates competition and an accompanying potential for conflict in space. Concern will grow for the security of both people and systems. Weaponizing space may offer an attractive solution, but it could be detrimental to industry and commerce in space.

Weapons in space may increase liability insurance for commercial space assets.[100] As it stands today, insurance costs are approximately 25% of the cost of placing a satellite into orbit.[101] Deployment of space weapons adds a new source of risk for space operations. In addition to the direct threat they pose, space weapons could create a debris hazard if used to destroy orbiting systems. This increase in risk could increase already high liability costs and reduce investments in space businesses. The projected boom might never materialize, compromising both the national and the global economy.

Although space weapons may be cost effective for military purposes by reducing force requirements, the economic benefits derived from these savings are on the order of billions or tens of billions of dollars. This is far less than the hundreds of billions of dollars to be derived globally from the economic growth projected in space businesses. Alternatives are needed to support national security interests without placing economic interests at risk.

Promoting Prosperity at Home.

Space businesses support several national interest objectives under "promoting prosperity at home." Commercial development is typically accomplished through international consortia,

often led by US corporations, with the US reaping many of the benefits. Benefits to the economy, both nationally and globally, could be jeopardized by the deployment of space weapons.

Enhance competitiveness. US corporations are leading the development of space businesses, creating new products and services for sale in the global market and new job opportunities for the US. Most of the new telecommunications satellites presently in planning or development will be built in the US.

Strengthen macroeconomic cooperation. There is potential for an unprecedented level of international cooperation in both civilian and commercial space activities. Today international cooperation is standard practice in space activities throughout the world, driven by economic necessity. The International Space Station is a prime example. Each nation would prefer its own space station, but no single nation has resources adequate to the task, not even the US. Pooling resources makes the undertaking feasible and all will benefit.

Enhance access to foreign markets. Most US corporations in space businesses participate in or even lead international consortia. The agreements establishing the consortia ensure access to foreign markets for all participants. Motorola's Iridium constellation is owned an operated by an international consortium to ensure access to the international telecommunications market.

Promote sustained development abroad. Commercial development in space typically is accomplished through international consortia. Economic benefits accrue worldwide as more nations become involved in producing parts for space systems and gain access to global markets. Nations seeking entry into the space market and corporations

using space infrastructure to develop new products or business ventures create new markets and new job opportunities worldwide.

Promoting Democracy.

The US as the leader in civilian and commercial space activities can influence actions of other nations by offering opportunities for cooperation. This was demonstrated recently when the US was able to deter Russian sales of cryogenic rocket technology to India in exchange for Russian inclusion in the space station program.[102] Cooperation in space on both civilian and commercial activities creates opportunities to influence other nations by allowing access to, or use of the technology and activities of spacefaring nations.[103] These are opportunities to pursue our objectives in "promoting democracy" which are the following.

Enlarging the community of democratic and free market nations.

Helping preserve new democracies.

Respecting human rights.

Deploying space weapons could jeopardize such opportunities. The momentum that exists now for cooperative development would be lost. Cooperation would be replaced by competition, with resources redirected from civilian and commercial to military efforts. It is clear that cooperation is critical to the development of space for the greater good of all mankind. It is not clear that weaponizing space offers benefits of comparable value.

ALTERNATIVES TO WEAPONIZING SPACE

Space weapons may support national interests by protecting space assets, and providing a cost effective means for defending against ballistic missile attacks and establishing a global military presence. Alternative approaches to satisfying these national security objectives should provide comparable support, be consistent with domestic and international law, and should not jeopardize commercial development in space. Since space weapons have not been deployed to date, these approaches also should consider deterring development and mitigating deployment of space weapons. Such alternatives include greater use of passive measures, such as intelligence and surveillance, attack warning, and exploiting technology more effectively as in information warfare, precision guided weapons, and UAVs.

Protection of Space Assets. Space assets provide access to sensor data and communications and information transfer capabilities that are critical to national security and must be ensured. Although USSPACECOM views space assets as the US "center of gravity" it is the data, the information, and the flow of information, rather than the hardware, which is the "center of gravity." The vulnerability is not necessarily in the space segment of the system, but can be in the ground segment that controls the system and processes the information, and in the links through which information flows. These are more readily accessible than space assets.

An adversary is beset by the same vulnerabilities as we are so we can hold his center of gravity at risk. We do not need to control space. Rather we need to protect and control our assets and prevent adversaries from using their assets against us. This can be accomplished without space weapons. Use of space assets can be denied effectively by jamming, by attacking

ground stations, and by corrupting information. IW techniques may be more effective and less vulnerable than space weapons. Orbiting weapons platforms can be tracked and attacked as easily as other space assets. They are as likely to be a target as a deterrent. IW offers the ability to deny, exploit, corrupt, or destroy the enemy's information and its functions, while protecting ourselves against those actions, and exploiting our own military information.[104]

If US space assets are attacked, we must ensure the availability of communications and information transfer ability. This can be accomplished in at least two ways: by deploying UAVs or by launching "quick replacement satellites." The Army After Next wargame raised the possibility of UAVs serving as wartime information systems and surrogate satellites. They could perform many of the functions of satellites in a theater, they are easily replaceable, and they may be equipped with weapons.[105] Small satellites with limited capability, designed for military support only, could be developed and stored until needed. As launch facilities improve, it should be possible to launch these on demand. Quick replacement satellites, are not a new concept. The Soviet Union has used this concept successfully for its reconnaissance activities.[106] A similar approach also is planned by the commercial sector. Although this would not provide protection to space assets per se, it reduces their value as targets.

Missile Defense. Any missile defense system can be overcome by a determined adversary willing and able to launch a sufficient number of missiles. The MTCR has been successful in reducing the number of states pursuing ballistic missile programs, and those states that still maintain such programs are more interested in short range missiles to be used against their regional adversaries. The only states that might consider an attack against the US do not have the missiles at present, nor the economic strength to support their development or purchase. Cruise

missiles and terrorist acts are considered the more likely forms of attack against the US, threats against which ballistic missile defenses or space weapons would be ineffective.[107]

Although the Persian Gulf War provides the rationale for pursuing ballistic missile defenses, the evidence indicates other methods were more successful in limiting Iraq's use of Scud missiles. Iraq was deterred from using WMD by threat of tactical nuclear retaliation. The air campaign prevented the launch of many Scud missiles, and the active defense system, Patriot, had questionable success in countering the ones that were launched.[108]

Space weapons would be of little or no value against short range missiles such as the Scud. Of greater value are sensors and intelligence to monitor adversaries' activities and to locate launchers. Destroying launchers or missiles on the launch pad is still a primary missile defense objective. UAVs able to detect and destroy launchers also offer a promising alternative.

Global Presence. We have global presence through intelligence, surveillance, reconnaissance, and communications satellites, and global influence through the information we control. If force projection is required, IW, UAVs, and precision guided weapons can provide the capability we need to intervene anywhere in the world. Information can be used to support national interests in a variety of ways. It can be used to deter or coerce an adversary and as a force multiplier. Information sharing can be used to engage other powerful states in security dialogues to prevent them from becoming hostile, and the US information edge can prevent hostile nations from becoming more powerful. It can be used to bolster new democracies and to communicate directly with those in non-democratic nations. Information also is an important tool in dealing with international crime, terrorism, proliferation of WMD, and environmental issues.[109]

An information umbrella could create a cooperative structure among friends, allies, and neutral nations, with whom we could share information resources, analogous to the nuclear umbrella of the Cold War era. The benefits space weapons could provide by instilling confidence in US support could be achieved without incurring the liabilities, and it would offer new ways for the US to maintain leadership in alliances and coalitions. The power of information as a political and diplomatic tool is yet to be fully exploited. Successfully applied, national security objectives could be met without force projection and without space weapons.

MAD Doctrine Analogy. The umbrella concept can be applied to sharing in the prestige of space, i.e., allowing access or association with technology and activities of space-faring nations as an incentive to deter proliferation of missiles and to deter development of space weapons.[110] Through cooperation in civilian and commercial space activities mutual dependency is established and security of space assets and information can be achieved. Nations with a stake in space assets and information are less likely to seek destruction of these assets. In addition, the opportunity to achieve parity in these areas with other nations, gives them a stake in the global community making them less likely to resort to hostile actions. *Knowledge is power*, and if knowledge is equitably dispersed potential conflicts are more easily avoided.[111]

International Authority. To alleviate any perceived need to deploy space weapons in order to protect against such an attack, we should consider an international authority to order sanctions and to adjudicate conflicts. This has not been a concern to date, at least not until last summer's incident between Hong Kong and Indonesia. Although justifiable, hostilities, other than

jamming, were avoided. World opinion and the reluctance to turn space into a battlefield were a powerful deterrent.

However, with international consortia preparing to launch constellations of commercial communications satellites, and with more nations entering the space market, conflicts are inevitable. This may be an opportune time to garner support for an international authority to resolve issues and conflicts. Such an organization could monitor threats of space weapons deployment and ensure the use of space is maintained for peaceful purposes. This could be accomplished through the United Nations or an organization formed specifically for this purpose. Since there is great potential for economic development stemming from space-related activities, it could prove advantageous to space-faring nations to support such an organization. Recommendations have been made for a "World Space Agency" to institutionalize space cooperation and reduce incentives for missile proliferation.[112] World opinion can be a powerful deterrent, particularly for those with a stake in the global community. This includes all stakeholders in space.

SUMMARY

From a purely military perspective, space weapons are an attractive option. They would be a force multiplier, able to provide continuous presence, global coverage and the ability to respond rapidly in a crisis, while reducing the need for forward deployed or prepositioned forces and reducing overall logistics and force structure requirements. Space would be defined as an AOR with CINCSPACE becoming a warfighter.

From a political perspective international treaties and agreements do not preclude space weapons although there are constraints, particularly for ABM systems and WMD. There is a tenet that space should be used for peaceful purposes only. However, the US has qualified this to mean for nonaggressive purposes, which could allow use of defensive space weapons. US deployment of space weapons would violate some international agreements and could encourage others to do the same.

Deploying space weapons raises the specter of another arms race, in both nuclear and space weapons, and a renewal of tensions and hostilities reminiscent of the Cold War. Instead of investing limited resources in economic development, nations might be compelled to increase investment in military capabilities and form alliances, if necessary to compete with the US.

From an economic perspective, the prospect of space as a battlefield increases liability costs and risks to commercial developers and could stifle growth of space businesses. Commercial development of space is important to the US and the global economy, and the international cooperation and economic development contribute to political stability.

Technologies for space weapons are being pursued and will be demonstrated within the next several years if funding continues. Successful demonstration could provide the momentum

for deployment, without consideration of the consequences. The decision could occur by default.

Attacks could be launched on space assets from the ground or in space with sources that are not readily identifiable or detectable. Such attacks could occur even if the US does not deploy space weapons. However, if the US sets a precedent for using space weapons it will be far more difficult to prevent their use by potential adversaries.

CONCLUSIONS

Space is not now a battlefield - Do we want to make it one? It is our question to answer now. The weaponization of space is not inevitable. At this point the US as a premier space power has an overwhelming influence on whether the world goes down this path or not.

Many of the rising threats to national security cannot be addressed with space weapons. Innovative use of space and information age capabilities offers national security protection without the political and economic liabilities of space weapons.

Space weapons could be a handicap by providing a false sense of security or invincibility. They are as vulnerable as any other space asset, and would be a prime target in any conflict. Deploying them encourages adversaries to develop similar capabilities or countermeasures. It also encourages us not to seek alternatives. Investment in space weapons could preclude investment in other methods to maintain military superiority such as precision guided weapons (PGW), unmanned aerial vehicles, and information warfare.

The prospect of space as a battlefield could stifle commercial development. There is greater merit economically and politically, for a strong space business and industrial sector. Investments in civilian and commercial space can provide diplomatic leverage to reduce national security risks without use of force. If force should be required, there are alternatives to space weapons. PGW, UAVs, and IW can provide the necessary capability.

In the absence of the immediate threat of any other nation weaponizing space, how do we deter development of space weapons and how do we mitigate their emergence by potential adversaries in ways not involving space strike weapons?

An important element for deterring development and use of space weapons is to develop sensors for attack warning. If an attack on a space asset can be identified as such, and if the source of the attack can be determined, aggressors can be made accountable. This would take attacks on space systems out of the realm of terrorism into legitimate warfare, and perpetrators could not escape the consequences.

However, the key to deterrence is international cooperation. Nations working together towards common goals are less likely to become adversaries. With limited resources cooperation is becoming the standard in the civilian sector, and in the commercial sector international consortia are used to guarantee market access. The US should take the lead in establishing an international authority, perhaps within the United Nations, to ensure access to, and peaceful use of, space for all nations, and to provide a forum for conflict resolution. Although the US is the premier space power, multinational commercial interests may dominate in the future. An authority able to address both government and commercial sector interests and conflicts could reduce future incentives for weaponizing space.

"As the competition in rockets in arms race and space race defined the Cold War, cooperation in space exploration and development may become a defining activity of the coming millennium."[113]

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